The InternSolution

Ways to use student interns to reduce the costs of energy and environmental surveys

Intro-Duction

This section describes the problem in detail, explains why the Nebraska Energy Office chose to use interns and gives a general idea of the costs and benefits of using interns. Readers should be able to recognize similar opportunities in their own organization and ascertain whether interns might be part of the solution.

The Lighting Survey Problem

Amidst great ceremony and with the best intentions, the State of Nebraska signed the GreenLights Memorandum of Understanding in March of 1992, becoming the eighth state government to enlist as a partner. A respected regional lighting vendor agreed to survey lights in state-owned buildings, the state would make cost-effective improvements, facility costs would decrease, tax money would become available for more important uses and the air would get cleaner. Twelve months later, nothing had happened.

This is not an unusual scenario. Most state government partners interviewed said that little progress had been made in their GreenLights efforts so far.

What went wrong?

The Environmental Protection Agency introduced its GreenLights program in 1991. In a radical departure from traditional "command and control" regulatory programs, GreenLights stresses voluntary, profit-driven cooperation between the agency and private sector partners. A company becomes a partner by agreeing to identify and install all cost-effective lighting improvements in its facilities. The identification and installation is financed by the partner, but the partner enjoys a high level of confidence in the predicted energy savings — something usually found in professional engineering studies. The EPA provides technical and programmatic support as a part of the GreenLights effort. Upgrading the lighting system reduces electricity waste and ultimately prevents pollution by decreasing power plant emissions into the atmosphere.

The key to confident identification of cost-effective lighting upgrades is the "lighting survey" — an inventory of the actual lighting equipment installed in each facility and an accurate analysis of the electricity and maintenance cost savings which could result if changes were made enhancing energy efficiency. The GreenLights Memorandum of Understanding treats surveys as low-cost items — EPA will provide training for the partners' staff to do their own surveys or provide a list of EPA-trained "surveyor allies" in the partner's geographic area. In Nebraska's experience, it is true that lighting surveys are a small percentage of the actual installation cost of the lighting upgrades, but that does not mean that the cost of surveys is easily financed. Staff time and commitment to receive training and begin surveying lighting systems may cost three to five cents per square foot. Lighting surveys are generally not something the maintenance department can do when there are a few free hours at the end of the week. If the partner chooses to hire a surveyor ally or other energy or lighting professional, costs may be as high as 12 cents per square foot.

In recognition of this problem, Nebraska turned to college student interns to survey lighting systems. A workshop and this manual, *The Intern Solution*, were developed to train other government, institutional, educational and non-profit organizations to use interns for similar tasks. The second chapter will provide sufficient information to determine whether the intern solution is appropriate for your organization. The remaining chapters discuss different aspects of an intern program in greater detail, describing the major steps necessary to begin and operate such an effort and some pitfalls to avoid.

History of Nebraska's Intern Program

In 1992, the Nebraska Energy Office received a grant from the U.S. Department of Energy to perform lighting surveys in public and private schools. One of the requirements of the grant was that work experience be provided for college and university students in technical disciplines. During that summer, the Energy Office hired six third- and fourth-year students from the University of Nebraska's College of Architecture and trained them to perform walk-through lighting surveys. These were not comprehensive surveys; interns only recorded data on lighting equipment which appeared to have good energy-savings potential. Nevertheless, over 1,500 lighting efficiency improvements with an average simple payback of 5.1 years were recommended in 270 school buildings.

Perhaps more importantly, it was discovered that students at the university were anxious for summer jobs where they could get real world experience in the building sciences. For architecture and engineering students, summer jobs rarely offer significant learning opportunities because by the time students learn an office system, their summer is over. The narrow focus of this program, lighting retrofits in public buildings, allowed sufficient training in a fairly short time period. Interns could then spend most of their summer surveying the buildings. The salary was competitive with most summer jobs and the work gave interns a chance to apply their education, develop a new area of expertise and experience the consulting engineering or architecture field first hand. Finally, the energy efficiency and environmental stewardship ethic of the program connected with students' natural idealism. The experience taught them to critique lighting and even building designs from an energy and environmental point of view. It is believed that at least some of this ethic will carry over into these students' future design and consulting work.

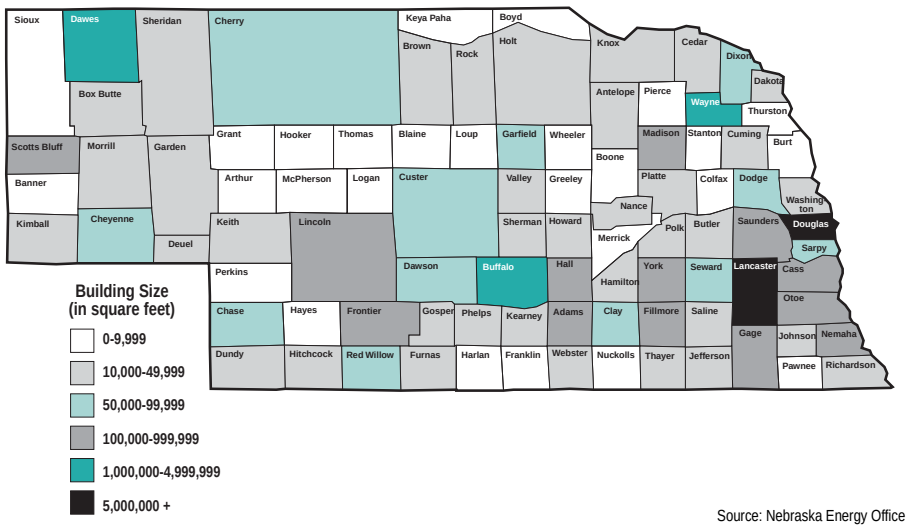
The Intern Solution

In the Spring of 1993, an EPA contractor came to Nebraska to try to get the stalled GreenLights effort moving. Representatives from many state agencies attended the "mobilization meeting" and one point quickly became apparent: none

of the agencies believed that they had either the human or financial resources to make GreenLights work. Even the offer of free training and software did not convince representatives that their staff had time to devote to lighting surveys and everybody knew that there was no money to hire outside consultants for the surveys. During the course of the meeting, some deals were made. The Energy Office agreed to survey 500 state buildings at its expense and provide the reports to the various agencies. The agencies would then be responsible for completing surveys on the remaining, mostly smaller buildings and installing the recommended upgrades.

At the time of this meeting, the Energy Office had been preparing for a second summer of lighting surveys, patterned after the school building surveys of 1992, but targeting local government buildings. The program had already been advertised at the university and prospective interns had been interviewed. This preparation allowed the GreenLights surveys to begin within two months because the only work left was to develop the database of state buildings, select those to be surveyed and learn how to use the GreenLights modeling and calculation software.

Distribution of Nebraska State Buildings



Source: Nebraska Energy Office

During the summer of 1993, six interns were hired to perform comprehensive lighting surveys on 240 state buildings. These were not all the largest buildings because it was considered important to provide surveys as evenly as possible among the state's 49 legislative districts. The next summer, six more interns were hired with program funds and assigned to complete surveys on the largest state buildings. Five additional interns were hired under contract with five state agencies. These agencies had contacted the Energy Office and asked the energy staff to train and supervise interns whose time would then be dedicated to buildings owned by the contracting agencies.

After three years of program operation, interns had completed surveys on 1,364 buildings covering 37.6 million square feet. The lighting upgrades recommended in these surveys are expected to cost $18.3 million and generate annual savings of

Buildings Surveyed, 1992-1994

Building Area in Square Feet	Number of Buildings Surveyed 1992	1993	1994	Total
Less than 499	1	16	173	190
500 to 999	4	22	185	211
1,000 to 4,999	15	65	168	248
5,000 to 9,999	24	44	79	147
10,000 to 49,999	146	48	158	352
50,000 to 99,999	67	35	77	179
100,000 or More	13	10	14	37
TOTALS	**270**	**240**	**854**	**1,364**

Source: Nebraska Energy Office

$1.94 million in electric savings[1] and another $645,000 in maintenance savings — a total of $2.58 million.

The total cost for three years of interns' wages, supplies, expenses and administrative costs for supervision and technical review (including contract costs in the third year) was $131,702. This averages $0.0035 per square foot surveyed or $97 per building. This is much less than the cost of detailing permanent employees to survey lighting systems in their free time or hiring a professional surveyor. Of course, professional assistance will still be needed for redesigning some of the more complex lighting systems, but lighting upgrades in most buildings can be completed without significant further design work.

Summary

The initial data collection, in this case lighting surveys, in a voluntary program represents a hurdle which is often underestimated. It is true that the costs of this phase are small in relation to the overall costs of the improvements to be made. However, it is easy for managers to treat these up-front costs as negligible. To the individuals assigned to complete the work, lack of reliable surveys is a major barrier to getting the program underway, making any improvements and realizing savings.

The facility manager usually has two choices: either dedicate staff time to both training and conducting the surveys or hire a professional surveyor. Both these options can be viewed as too expensive. Lighting surveys are not simple enough that an existing staff member can take the training course and then do an occasional survey when there is an afternoon free. Consequently, staff get trained, but never seem to have the time to do the surveys. The other option is to hire an outside consultant to do the surveys. There is a growing group of individuals who are trained to do lighting surveys, but costs may be high for a product which does not always require a professional consultant.

Therefore, the program sits unimplemented while cost-effective energy saving and pollution prevention opportunities sit unidentified and unexploited due to a lack

[1] The savings figures for the second and third years are skewed toward longer payback projects because these represent all potential lighting upgrades identified by the interns, not just those that appeared to be cost-effective. The second and third year surveys were also on state buildings with an average electric cost of $0.031 per kilowatt-hour.

of low-cost, reliable lighting surveys. This is especially difficult for non-profit, governmental and quasi-governmental agencies which operate on contributions or tax revenues. These groups are less likely to be able to dedicate staff time or afford consultants, yet might benefit most from reducing their operating overhead because they do not have a means of passing their operating cost on to their "customers."

Interns can fill this gap. They are, by their very nature, temporary employees who work cheaply because some of the benefit they derive from the position is in the job experience itself. An intern brought into an organization is able to start fresh, without commitments to other programs, and concentrate on accomplishing the survey task. Finally, interns can bring a higher level of technical understanding to the job than many maintenance people. What interns lack in practical experience can be provided sufficiently in a week of training because the purpose of the survey is only to explore and identify the possible savings.

By spending less time and money on the lighting surveys, organizations will have more of both to spend on implementing recommendations — actually installing the improvements which will save energy, money and prevent pollution.

Additional Information on Nebraska's Lighting Survey Programs

1992 Program: Public and Private K-12 Schools

During the summer of 1992, the program targeted public and private school buildings throughout the state. Surveys were requested for 401 buildings and 270 received surveys. Priority was based on historic electricity use (per square foot) and percentage of lighting provided by incandescents. The buildings were large with fairly complex plans. A comprehensive inventory was not required so interns only recorded data on the most inefficient fixtures observed. Calculations were done by hand. Buildings were well dispersed geographically, so travel costs were high. They might have been higher, but three interns were placed in remote offices in their hometowns and were assigned buildings in those areas. Office space was donated by Omaha Public Power District and the City of Hebron. One half-time intern reviewed the completed reports for accuracy and completeness and entered results into the program data base.

This initial survey program, which was funded by a $28,000 grant from the U.S. Department of Energy, was supposed to accomplish the twin goals of helping schools reduce their lighting electricity use and provide an introduction to energy issues for college students in the building sciences. Nebraska also used this program to market loans at zero and five percent interest and the Institutional Conservation Program to the schools. To date, lighting upgrades totaling $414,000 identified by the interns have been financed.

1993 Program: State Buildings

In 1993, the program was revised to fulfill the State of Nebraska's commitment to the GreenLights program. Oil overcharge trust funds were used to hire interns to survey state-owned buildings. The buildings ranged in size from over 500,000 square feet to less than 100 square feet and the plans varied widely in complexity. Although the largest office and classroom buildings were initially targeted, the need to survey equal numbers of buildings in each of the state's 49 legislative districts meant that most of the largest buildings did not receive surveys. Surveying buildings in each legislative district also produced a wide geographic dispersion, requiring high travel costs for the Lincoln-based interns. These surveys included a comprehensive inventory of lighting equipment. Most analysis was done using GreenLights' Decision Support Software.

Inadequate planning for technical review produced a backlog of reports at the end of the summer. The reports were not delivered to the agencies which owned the buildings until March 1994, which delayed inclusion of upgrades in agency budgets.

1994 Program: State Buildings

The 1994 program was a continuation of the 1993 GreenLights effort. Eleven interns were hired, six with oil overcharge trust funds and five under contracts with various state agencies. The Energy Office targeted the state's largest buildings this summer. Contract interns worked on buildings owned by the various agencies. Some buildings, such as those owned by the Game and Parks department, were very small, but extremely numerous. Other contracts for state colleges and state hospitals targeted larger buildings.

Two of the interns returned from the summer of 1993. They were given some administrative and technical review responsibilities which greatly reduced the backlog of reports at summer's end. All reports were delivered to the agencies in September 1994.

Deciding on an Intern Program

This section describes the factors to consider in whether to start an intern program. Readers will learn the potential barriers and various costs which should be considered and be able to create a program budget.

Organizational Commitment

It is possible to fit one or two interns into a typical office without affecting anyone other than their supervisor. However, if a full-scale lighting survey program with numerous interns is being considered, it is going to have an effect on the dynamics of your office environment. There is great value in building a team mentality in which the interns start to view themselves as lighting survey "special forces," but that attitude and the overall enthusiasm and energy that interns bring to their work sometimes manifests itself in a jovial camaraderie that may be disruptive. Interns may keep unusual hours, require extra office space and supplies and use up computer resources. None of these are major problems, as long as there is a general commitment to the survey program throughout the office and especially in the upper levels of office management.

Interns need to be aware of potential conflicts as well. They need to realize that there are long-term professionals in the office who have nothing to do with the survey program, derive no benefit from it and consider it something of an imposition on their normally placid schedule and work environment. A little common sense coupled with an awareness of potential problems will go a long way toward minimizing conflict.

Program Supervisor

Managing a group of interns for a survey program can be a lot of fun or it can run you ragged — or both — depending on the attitude you bring to the job. Interns bring an excitement and enthusiasm which is refreshing and infectious in the normal office environment. Since internships are usually short-term, the survey program supervisor will probably be overseeing this program in addition to other normal, full-time assignments. That means that the supervisor must delegate as much day-to-day responsibility to the interns as they can handle. It may be advisable to designate one or two interns to handle certain administrative tasks such as reviewing timesheets or tracking status and progress of building surveys.

Someone must be available to provide technical assistance as well. This person must be able to solve computer problems, advise on appropriate lighting upgrades, correct technical misunderstandings and provide additional training as necessary to avoid future mistakes. Finally, this person must be able to provide technical review of the completed survey reports to verify that the estimated savings are reasonable and that lighting upgrades are appropriate for the buildings and spaces where they are recommended. The supervisor and technical advisor may be the same person, or these duties may be divided among a small team.

Interns appreciate a supervisor with whom they develop some rapport. Some will seek and appreciate this contact more than others, but in general, interns want a job with a human face. It is important to take the time to know and treat interns as persons and to welcome and even initiate personal conversation at an appropriate level.

Program Costs and Benefits

Detailed costs for the Nebraska program are listed on page 11, but some general information is presented below to help begin the process of deciding whether some form of *The Intern Solution* is appropriate for your organization. This discussion is based on Nebraska's experience, providing lighting surveys in a wide variety of school and state-owned buildings. Undergraduate architecture and engineering students were employed, at an average cost of $6.00 per hour (including FICA withholding). Six to eleven interns were employed during each of three summers. The staff architect and engineer managed the program at an average cost of $16.80 per person per hour, including benefits.

The survey program cost for an average summer of six interns working for 13 weeks was $32,925. The various cost categories are shown in the pie chart on page 9.

During a typical summer, six interns should be able to complete survey reports on about 340 buildings covering 9.4 million square feet and identify lighting improvements costing $4.6 million. The simple payback for these may range from two to eight years, depending on local electric and labor rates.

For a specific building example, consider a 50,000 square foot office building of average complexity. A trained intern could walk-through this building in about half a day and

Typical Survey Costs for a 50,000 Square Foot Building

Survey Costs

Intern wages	$78
Supervisor salary	$31
Travel expenses	$16
Operating expenses	$11
Total survey cost	$136

Typical Analysis

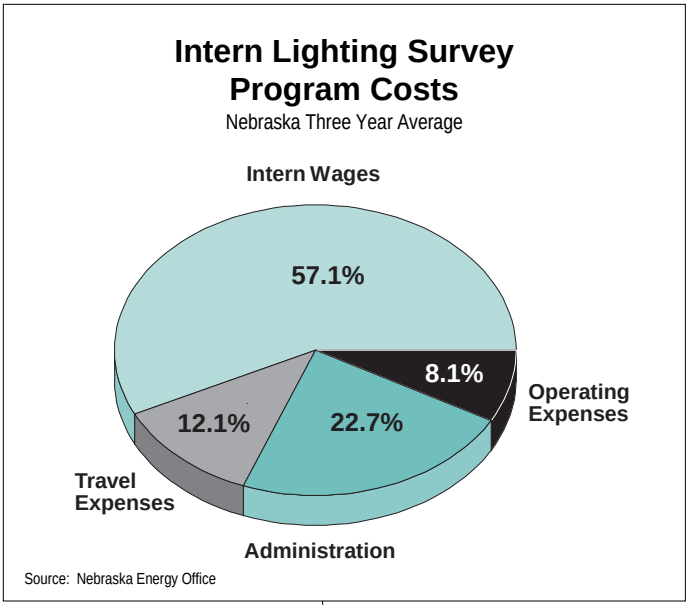
Cost of improvements recommended	$24,330
Electric cost savings @ 5 $^{1}/_{2}$¢ per kilowatt-hour	$4,010/year
Maintenance cost savings	$1,287/year
Total cost savings	$5,297/year
Simple payback (electric only)	6.1 years
Simple payback (all savings)	4.6 years
Internal rate of return (IRR)	21.5%

Savings

Electricity savings	72,900 kilowatt-hours per year
Carbon dioxide pollution prevention*	98,415 pounds per year
Sulfur dioxide pollution prevention*	331,812 grams per year
Nitrogen oxides pollution prevention*	134,456 grams per year

*Based on national averages

Source: Nebraska Energy Office

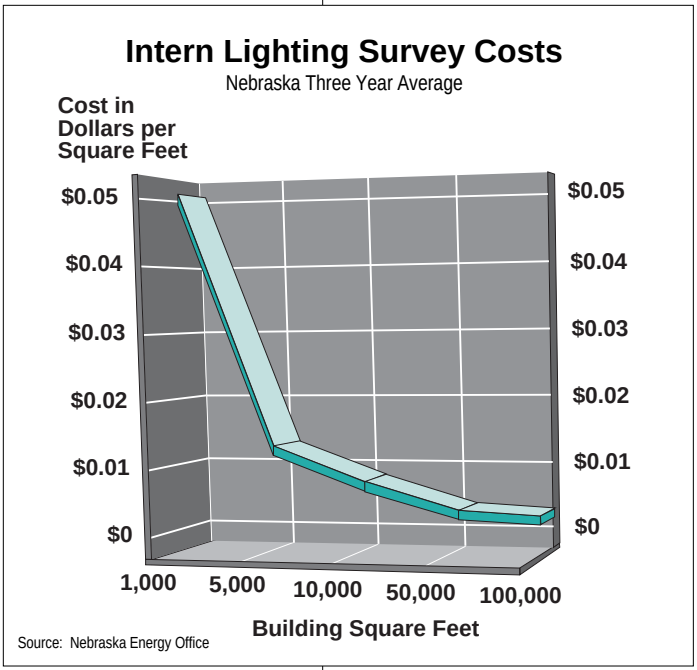


another full day would be required to complete the analysis and write the survey report. Another 1.8 hours of supervisor time should be apportioned to this building for administration and technical review, including a portion of program start-up costs. The expected costs and benefits are shown on page 8.

Staff Costs

Allow at least three months from the time you get approval for the program to the time training begins. Six months is probably more realistic. During this period, you must determine the buildings that will be targeted for surveys and gather data on those buildings, advertise the program and hire interns, collect equipment and prepare administrative procedures, training materials and computer support for the interns. These program start-up considerations will be discussed in greater detail in the next chapter.

Supervisors should allocate 20 to 40 percent of their time for program preparation and operation. The tasks may be shared by several individuals. Technical training will require a full time commitment for at least a week. The first few weeks after training will require between 40-80 percent of the supervisor's time as initial problems, computer glitches and issues that were not properly understood during training are resolved.



Intern Costs

In addition to hourly wages and FICA withholding, you may need to allocate program money to reimburse interns for travel and lodging expenses. Nebraska's program required each intern to have access to a reliable, insured vehicle and interns were reimbursed 27.5 cents per mile. Most interns felt that they made money on the mileage. Actual meal and other expenses were reimbursed based on receipts and lodging was billed directly to the state. These travel costs added about 21 percent to the intern's wage costs and comprised 12.1 percent of the operating budget for the survey program. These figures represent a program in which the surveyed buildings were dispersed

throughout the state, so a different target group of buildings might not require as much travel.

Operating Expenses

Operating costs for the program may include computers and printers, lightmeters and other survey equipment, forms and printer paper, copying, filing, mailing and telephone costs. These might also include basic office expenses such as staples and pens and even office space expenses. In Nebraska's case, there were available office spaces with desks and tables, to which interns were assigned. Five interns could share three workstations in a large cubicle (200+ square feet) with little conflict. In the final year of Nebraska's program, when 11 interns were officed, it was decided not only to rent faster (486/33) computers, but to rent a laser printer for sole use by the interns. This reduced conflicts with staff members over shared office printers.

Intern Benefits

The program costs and benefits previously described assume the availability of interns who are excited about the job opportunity and believe they will derive significant benefits from the experience. Nebraska's approach has been to pay an hourly wage and invest as much responsibility in the interns as prudently possible.

Decent Wage

The more you are able to offer, the more qualified applicants your intern program will attract. The salary should be comparable to other part-time, entry-level technical work — a dollar or two higher than minimum wage should be considered.

Course Credit

The availability of scholastic credit indicates that the educational institution finds value in the training and experience that the interns gain through the job. In Nebraska, where the program was operated by a government agency, the course credit from the university was optional. Only a few interns actually availed themselves of the opportunity because, by the time they reached their junior and senior years, most had already planned the courses needed for graduation and didn't need the extra credit. Nevertheless, the fact that credit was available gave the internships greater credibility compared to other summer jobs.

Deciding on an Intern Program

Lighting Survey Costs, 1992-1994

Lighting Survey Costs and Benefits Nebraska Energy Office, 1992-94	1992	1993	1994	3-yr total	3-yr average	% of costs
Costs						
num of interns	6.5	4.5	11	22	7.3	
interns- hours	3474	2755	6314	12,543	4181	
wages	$20,568	$16,307	$38,329	$75,204	$25,068	57%
admin - hours	402	667	709	1778	593	
wages	$6,763	$11,893	$11,254	$29,910	$9,970	23%
total personnel cost	$27,331	$28,200	$49,583	$105,114	$35,038	80%
travel costs	$6,046	$5,472	$4,394	$15,912	$5,304	12%
operating expenses	$2,015	$1,469	$7,192	$10,676	$3,559	8%
total survey costs	$35,392	$35,141	$61,169	$131,702	$43,901	100%
surveys completed						
number of bldgs	270	240	854	1364	455	
square feet	14,205,373	7,686,563	15,717,295	37,609,231	12,536,410	
cost of recommends	$2,085,046	$6,190,875	$10,024,906	$18,300,827	$6,100,276	
est kWh$ savings	$412,764	$681,623	$850,059	$1,944,446	$648,149	
est maint$ savings	n/a	$209,313	$436,171	$645,484	$322,742	
est total$ savings	$412,764	$890,936	$1,286,230	$2,589,930	$970,891	
est kWh savings	7,636,478	20,008,273	27,189,998	54,834,749	18,278,250	
avg bldg size	52,612	32,027	18,404		27,553	
SP: elec only	5.1	9.1	11.8		9.4	
SP:elec+maint	n/a	6.9	7.8		6.3	
elec price: $/kWh	$0.054	$0.034	$0.031		$0.035	
calculated output						
days per intern	67	77	72		71.3	
weeks per intern	13.4	15.4	14.4		14.3	
intern days	434.3	344.4	789.3	1567.9	522.6	
intern weeks	86.9	68.9	157.9	313.6	104.5	
bldgs/intern per day	0.6	0.7	1.1		0.9	
bldgs/intern per week	3.1	3.5	5.4		4.3	
sq.ft./intern per day	32,709	22,319	19,913		23,987	
sq.ft./intern per week	163,468	111,561	99,540		119,927	
calculated survey costs						
cost per building	$131	$146	$72		$97	
cost per sq.ft.	$0.0025	$0.0046	$0.0039		$0.0035	
cost per $ recommend	$0.0170	$0.0057	$0.0061	$0.0072	$0.0072	
cost per $ saved	$0.0857	$0.0394	$0.0476	$0.0509	$0.0452	
total program cost						
survey+installation	$2,120,438	$6,226,016	$10,086,075	$18,432,529	$6,144,177	
survey cost, % of Tot	1.7%	0.6%	0.6%	0.7%	0.7%	

Source; Nebraska Energy Office

Responsibility

At the beginning of the summer, interns received a data sheet for each building they were to survey. It was the interns' job to organize their assigned buildings into cohesive groups, contact the building managers, schedule trips, conduct the on-site building walk-throughs, recommend appropriate lighting improvements, analyze and verify the results and prepare reports. Supervision was minimal except to correct technical, procedural or personnel problems. The purpose of this approach was to minimize the supervision responsibilities of the program managers and encourage interns to rise to a higher level of responsibility.

Flexibility

Interns had significant flexibility in scheduling their tasks. This is consistent with the approach of treating the interns and their work professionally. Although limited to 40-hour work weeks by state rules, interns had the opportunity to schedule both day and overnight trips to best fit with their other activities. Interns also determined the pace at which they surveyed buildings and planned adequate time in the office for analysis and report writing. Since interns received no paid vacation or sick leave, they were allowed to work additional hours to make up for sick days or holidays when the office was closed.

An Intern's 1994 Experience

One of the 1994 interns wrote a 20 page paper as part of the requirements for additional architecture course credit offered through the University of Nebraska. It included a discussion of the GreenLights program in general and the results achieved by the 1994 intern team. Here are several excerpts from that report which deal more with the intern experience.

"The training period was somewhat overwhelming because we were given a lot of information very quickly and then basically sent off to work. We did a complete survey of a building with our supervisors from start to finish and it quickly became apparent that on-the-job training and experience was going to be more beneficial than anything we would learn in a training session.

"This work experience also gave me several 'revelations.' First of all, it became horribly apparent that lighting has been one of the most commonly overlooked design elements. This can be seen from several different perspectives. From the perspective of aesthetics, the University of Nebraska at Omaha Fine Arts Building is a good example. This building, constructed quite recently, has been featured in *Architecture* and is generally considered to be an effective building. While the lighting used in this building makes an obvious attempt at being energy efficient, it appears as though aesthetics have been sacrificed for efficiency when this does not need to be the case. Industrial fixtures designed for warehouses are used in classrooms and compact fluorescent fixtures that are extremely energy efficient stick out of the walls as though they were an afterthought. Aesthetics do not have to be sacrificed for energy efficiency as they were in this case. The two should be combined to create an overall lighting scheme that works effectively and efficiently.

"A final perspective on lighting design is the ergonomic factor. Employees in offices that were poorly or inefficiently lit were more likely to complain to me about the lighting and ask how I could improve it.

"Another 'revelation' from this summer is the financial impact that lighting design has. It seems that when students consider the life cycle cost of a building they are only concerned with the heating and cooling of the building. While this is also extremely significant, lighting design can play a major role. Natural light becomes just as important in design as natural ventilation and shading because poor use of natural lighting and reliance upon artificial means of illumination can add a tremendous burden to the life cycle cost of a building.

"The GreenLights Program has a lot to offer. The hardest part of the program was convincing people that I could cut the amount of wattage and maintain their current lighting level or even improve it. For the average Joe Q. Public, the ideas presented by GreenLights don't always make sense until he sees concrete evidence.

"After such a short training period we didn't feel comfortable with what we were doing, but by the end of the summer we were talking as though we were experts. I enjoyed talking with people about changes that could be made in their buildings.

"My experience from this summer has already begun to affect my work in the studio.

"I'm sure that this experience will continue to influence my designs through the rest of my education and I would strongly recommend this program to other students."

Travel

Interns seemed to enjoy the travel opportunities afforded by the program, even though it was all in-state and business related. During interviews, applicants were asked how much and in what parts of the state they wanted to travel. Building assignments were based in part on these preferences. Some interns scheduled travel to coincide with a weekend visit to friends or family, in which case the program reimbursed mileage to and from the furthest building survey location.

Realistic Experience

One of the primary goals of Nebraska's program was to give the interns a true taste of the job of a consulting engineer or architect. This was possible because the problem was small and easily defined: "recommend energy-saving improvements for the lighting system." Thus, interns could learn the task quickly and do their field and computer work with minimal supervision. Liability issues were covered by the Energy Office's technical review and the fact that the interns were not expected to produce complete, perfect lighting designs, but only to explore the realm of potential energy-efficiency improvements and recommend

Intern Comments

This is a compilation of some of the more insightful comments from the 1994 interns' exit interviews:

1. Was the job what you expected?
- Thought it would be a lot harder
- A lot more fun (and interesting) than it sounded
- A little more technical than I expected
- Learned more than I planned on

2. What was the best part of the job for you?
- The people - it was a really fun group
- Having the responsibility of completing the projects from start to finish
- How well we worked as a group
- The practical experience
- All I learned

3. What was the worst part of the job for you?
- Initial difficulty in recognizing fixtures
- Determining correct hours of operation
- Reviewing reports
- Monotony of surveys
- Computer program was very dry
- Repetitiveness of data entry

4. How will this experience be helpful in the remainder of your schooling?
- Combine aesthetics with energy efficiency
- Design studio: lighting and how it affects people using the space
- Part of my future designs. I will never overlook lighting again
- A better idea of appropriate lighting and its costs
- More comfortable with lighting issues
- Lots of new design ideas from buildings I've seen - good and bad

5. How will this experience be helpful in your professional practice?
- More aware of issues they don't teach you in school - new job opportunities
- Utilizing most advanced, energy-efficient lighting systems
- Made me aware of the importance of details
- Opened my eyes to a whole new area of expertise
- Everyone in the architecture profession should take a more in-depth look at lighting and energy efficiency
- Aesthetics and energy efficiency - good combination for a future with diminishing resources

6. How have your attitudes and awareness of energy in building design changed?
- Awareness of what is and isn't energy efficient
- Have put efficient bulbs in my room and my fraternity
- Really surprised that lighting design has been so neglected and the fact that so much energy can be saved by upgrading lights
- More energy-conscious - we have not turned on our air conditioner all summer and we don't leave unnecessary lights on

7. Did you receive an adequate level of supervision?
- Very appropriate - let us solve most of our own problems and work according to our individual methods, but offered assistance and advice whenever needed
- Yes - door was always open
- Could use more complete references and cost lists
- We had enough freedom to work independently, but they were involved enough to know what was going on with each individual
- Sometimes conflicting information between supervisors

8. Was it helpful to have more experienced interns providing leadership?
- Yes - they understood the problems we faced
- Only in the first couple of weeks
- Yes, but would have been better if everybody gave the same answers to questions
- Especially at the beginning
- Good for advice on upgrades to try so we didn't have to bother supervisors
- No
- Practical experience for things that "popped up" in the field
- Should have one in the office all the time, not doing any surveys

9. Was your initial training adequate?
- Can only learn so much in theory - best to get out and DO IT
- Very overwhelming - so much happened that I don't remember
- No - I had a lot of questions when we were on our own
- Felt confident when going out separately
- Some of the technical knowledge didn't seem to apply
- A little overwhelming
- Didn't seem adequate at the time, but it was

those that were most promising. Responsibility for the suitability of recommendations fell on the building owner or a designer or contractor retained to implement the recommendations. This gave interns the opportunity to make significant recommendations in a safe environment.

Significant Task

Interns are typically very idealistic. This job gives them an opportunity to get out and "make a difference in society" by recommending improvements which are cost effective, environmentally sound and energy efficient. Since recommendations are based on sound technology and are generally noncontroversial, it is easy to feel good about the work.

Useful Training

Initial training topics are chosen for maximum utility. The purpose of the initial training is to give interns the knowledge and skills needed to do the

job well. This involves some conceptual information, but primarily consists of demonstrating practical information that interns must apply. This quickly differentiates the internship from normal classroom lectures and provides a sense of applicability and progress. After interns become comfortable with the mechanics of their job, additional topics should be introduced depending on the interns' interests. Small, practical design problems, videos and field-trips can provide short "vacations" from the normal survey task and reinforce the understanding that, even as interns are doing the job, they are also learning information which will be valuable throughout their professional careers. Some of the additional training was voluntary, but interns were paid for time spent in continuing education.

References

Since interns were in their final year or two of school, one of the benefits of the internship was the opportunity to get some practical experience which would look good on a resume. Additionally, supervisors offered to provide references for graduate school or a full-time job.

Program Start-Up

This section describes the administrative and personnel decisions, agreements, policy directions, data collection and organization needed before beginning an intern program. Readers should gain an understanding of all the necessary steps and be able to organize a coordinated approach to accomplish these preliminary tasks.

The success of an intern program depends on many factors. The scope of the project, the dedication of the people involved and the thoroughness of those efforts will all have a dramatic effect on the outcome. The program can be made more successful by anticipating questions and making as many decisions as possible before interns arrive for training.

By their nature, internships are short-term learning experiences, usually lasting less than a year and often, only a few months. To maximize the effectiveness of the internship, a great deal of planning is required before the program begins. Once surveys are underway, implementing changes other than small adjustments, will distract from the survey process. Procedures must be established, equipment available and buildings ready to be surveyed when the interns finish training. This internship is an action-oriented program and interns expect to get to work. Delays and uncertainty will hurt morale and hinder your program.

The program start-up phase consists of bringing together a number of diverse elements at the proper time. These include:

- Goals. Know what the program is supposed to accomplish
- Funding. Resources are in-place, available and any restrictions resolved
- Buildings. Target groups are selected, prioritized, data collected and assigned
- Interns. Internships are advertised and interns are hired
- Training. (To be discussed in the next chapter)
- Tools. Equipment, supplies, computers and space are acquired
- Procedures. Administrative, personnel and program policies are finalized

This chapter will discuss each of these elements and the issues which should be decided ahead of time. Examples will be given from the Nebraska program, which may be similar to the decisions needed in your program. It will also discuss the impacts that certain decisions may have on your programs.

Goals of the Survey Program

Define your program thoroughly in terms of the goals and objectives you plan to accomplish. Also decide what your program will not accomplish. Is your goal to survey a certain number of buildings, to implement a utility's integrated resource plan, to market energy efficiency or pollution prevention or to provide employment and educational opportunities? Often, at least some of your goals will be dictated by the availability of funding. In any case, you must decide at the outset exactly what the program parameters are and make sure those parameters are respected. Having parameters clearly defined allows you to address other program decisions.

Funding

Funding for your survey program often depends on the goals or may even dictate those goals. Typically, you will have most funding committed early in the program's development so that any financial restrictions can guide later development decisions. This manual describes how using interns can reduce survey costs, but surveys will never be free. Even if interns are volunteers or are required to participate for class credit, there will be costs for equipment, supplies, travel and supervision.

Funding sources may include grants from parties not directly involved in the surveys, partnerships with entities who are involved in the planning and operation of the program and service fees or reimbursements from building managers who benefit from the surveys.

Each of these entities may have different reporting requirements which may include financial, status and program reporting for the entire survey program as well as copies of survey reports and recommendations for all or a portion of the buildings surveyed. These requirements should be clearly identified during initial planning so that you can design the appropriate reporting procedures in your program. Any required forms or reproducible originals should be obtained ahead of time and in sufficient quantity.

If you will be reimbursed for survey costs by the owners of buildings, you may need to develop a simple, standard contract or letter of agreement specifying the work to be done, reports to be delivered, basis for charges and other information specific to your situation.

Since funding details will vary greatly from program to program, the issue will not be addressed further in this manual.

Building Selection and Prioritization

If your program goals do not limit surveys to a particular group of buildings, what type of buildings will be surveyed must be decided. Some questions to consider in making this decision:

- Do surveys need to be apportioned equitably among several sponsors or among political subdivisions? If so, is it more important to proceed uniformly among the groups at the start or should one group be finished before another is started?
- Are certain buildings likely to benefit more from a survey? These might include buildings with high lighting loads, many inefficient lamps, poor controls and long hours of use or expensive utility rates. Other considerations might also include buildings in disadvantaged neighborhoods or those with owners in financial distress.

- Will results in a single building or group of buildings generate additional program opportunities? These may be buildings which are more visible because they are used by many people or supported by taxes, contributions or user fees or are likely to attract media attention.
- Have the managers of certain buildings made a prior commitment to make the recommended changes or do they have a history of implementing projects when shown the advantages? The likelihood of implementation is a great motivator for interns and helps the overall success of the survey program.
- Do certain building managers have funds or financing opportunities available to implement recommended improvements? Implementation, followed by tracking of utility bills to verify savings, may provide support to continue or expand the survey program.
- Is there a need to limit which buildings are eligible for surveys or can other building types be added later?

Consideration of factors such as these will help define your program's target buildings. After this has been decided, advertising the availability of surveys may determine which building owners are most receptive to the program. This may not be needed if a commitment has been made. In this case, the collection of pre-survey data to prioritize the buildings could begin.

Pre-Survey Data Collection

Time at a building site can be reduced and made more effective by careful planning and collection of as much information as possible before the walk-through survey. While information about a building can be collected at any time prior to a site visit, if the information is available during the start-up phase, it can be used to prioritize buildings so that those which are most likely to benefit from lighting improvements can be surveyed first. Detailed building information prior to start-up may also affect your selection of interns, if that selection is based on geographic considerations. Finally, building information will permit more strategic trip planning which can reduce your program costs.

Unless you have a very small number of target buildings and can interview each owner or manager personally, you will probably need to send out a questionnaire to building managers to request the necessary information. This questionnaire can be easily combined with an announcement of program availability, so that by responding to the questionnaire, the building manager is also requesting a survey from your program.

Your pre-survey questionnaire should request all the information listed as "Building Identification" and "Building Information and Energy Use" for the

Example of Database Contents

Building Identification

- Building name, mailing address and physical location
- Building contact name, title and phone number
- Owner or responsible agency, contact name and phone number
- Complex or facility name, (if applicable

Building Information and Energy Use

- Building type and primary building use (maybe a checklist)
- Year of construction and additions
- Floor area
- Annual hours of use (full- and part-time)
- Electric utility name and phone number
- Twelve months of electric bill data (kilowatt-hours, kilowatts, cost)
- Base electric load estimate

Survey Information

- Assigned to intern
- Priority number, if applicable
- Status (keyword, checklist or date completed)

Survey Results

- Estimated current lighting cost and kilowatt-hours
- Upgrade cost(s)
- Savings (kilowatt-hours, kilowatts, dollars, maintenance)
- Payback, internal rate of return or other benefit-cost criterion
- Implementation status
- Location of paper file

Flat File Versus Relational Databases

If you have a lot of information which is being repeated from one record to the next, you may want to investigate a relational rather than flat-file database for information storage. In a relational database, repetitive information is entered only once and is matched with all the records to which that information applies by a "key" field. In this case, if you have a number of buildings which are owned by the same agencies, you can enter the contact information once for each agency and then mark which buildings belong to each agency. Similarly, if there are many buildings on central electric meters such as a college campus, the meter data should be entered only once and the record for each building drawing from that meter should point to the single meter record. This is a more efficient and accurate way to store data, but it requires a more sophisticated database program and usually some programming time.

database shown on this page. You may want to request information on the lighting equipment currently used in the building as well. This should be general enough that you are not asking the building manager to complete the survey for you, but concentrations of inefficient lamps may indicate a building which could achieve significant benefits from the survey program.

You should also request a building plan of some type. This is a valuable and often-overlooked tool. The most desirable — and rare — is an actual electrical lighting plan. A good alternative is a reflected ceiling plan. A simple floor plan with dimensions, or at least drawn to scale, is next in order of desirability. If none of these is available, there is usually an evacuation plan which can be copied. Even a rough sketch of the building outline and major rooms is better than nothing — the intern can always redraw this more accurately during the walk-through survey, if necessary.

Finally, if your program targets buildings owned or operated by disadvantaged individuals or if the buildings are located in low-income or blighted areas, you may also need to request information about these factors. This information may be used to determine eligibility, priority or both.

Two examples of pre-survey questionnaires are shown at the end of this chapter on pages 35-37.

Estimating Your Program's Capabilities

Usually, the number of available interns is limited by program funding, availability of space and other tools or even administrative overhead.

Building Inventory Computer Screen (Page 1)

Records Organize Go To Exit

Building ID# 0001-0

GREEN LIGHTS BUILDING INVENTORY

Building Identification:
STATE CAPITOL
1445 K ST
LINCOLN , NE 68509
County: Lancaster
Legislative District: 28

Contact: BOB RIPLEY
Phone:

Building Owner/Operator:
Agency# 065-04
Agency: Administrative Serv.
Division: STATE BLDG.

Contact: DANNY SCHLICHENMAIER
Phone:

Complex: CAPITOL COMPLEX

Primary Use: office building
Secondary: museum

Full Time: 2600 hr/yr
Part Time: 1040 hr/yr

Constructed: 1932 Construction Type: load bearing masonry wall & steel
Remaining: 75yrs Size: 289,400(net) 401,760(gross) floors:18

Primary Heating System: central Primary Cooling System: central

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Building Inventory Computer Screen (page 2)

Records Organize Go To Exit

Electric Utility: LES
City: LINCOLN Phone:

electric metering: indiv sq.ft. on central meter: 0

	Electric Consumption kWh	cost	Demand Metered? N kW	cost
Jan	430,536	$10,333	0	$0
Feb	216,280	$5,191	0	$0
Mar	590,488	$14,172	0	$0
Apr	176,216	$4,229	0	$0
May	455,888	$10,941	0	$0
Jun	443,568	$10,645	0	$0
Jul	283,664	$6,808	0	$0
Aug	368,264	$8,838	0	$0
Sep	355,320	$8,528	0	$0
Oct	377,048	$9,049	0	$0
Nov	238,568	$5,726	0	$0
Dec	521,360	$12,513	0	$0

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You can use this section to estimate how many buildings interns can survey.

In general, Nebraska's interns found they could walk-through about 100,000 square feet (in one or several buildings) in an eight-hour day. Another two to three days would then be required for travel, data entry, analysis and report preparation. These estimates and the averages in the table on page 20 may need to be modified according to specific features such as:

- Small buildings require more time per square foot than larger buildings. There is a minimum amount of overhead time required for each building for travel, information collection, analysis, report writing and administrative time, regardless of the size of the building.
- A building's location may require extra travel time and even overnight stays. Remote locations may also limit the number of interns available to perform some surveys, particularly if interns are working part-time and have other job or educational commitments.
- Complex buildings, with many different types of rooms, schedules and luminaire types, require much more survey time than similar-sized buildings which have a single schedule, only a few luminaire types and many

Estimating Intern Survey Output
(Including travel, walk-through, calculations and reporting)

	Per day	Per week
Buildings surveyed per intern	0.9	4.3
Square feet surveyed per intern	23,987	119,927

Source: Nebraska Energy Office

similar rooms. Some buildings such as dormitories are extremely simple because of repetitive features. Occasionally, you will also encounter identical buildings, where several reports can reference the same analysis and recommendations.

• Comprehensive inventories of a building's lighting equipment and comprehensive lists of recommendations add to the time required for the walk-through survey, analysis and report writing, compared to simpler surveys. More surveys can be completed if interns only inventory and analyze lighting equipment that they know can be economically replaced or only recommend particular technologies. However, this will reduce the overall savings and may result in missed savings opportunities, both at the time of the survey and in the future.

Priority List

If you lack the time, interns or money to provide surveys for all your target buildings, then you will need some criterion for deciding which buildings are surveyed and in what order.

This criterion may be dictated by your goal or funding source such as financial need or location within various utilities' service territories or political subdivisions. If these situations do not apply, then you will probably want to prioritize surveys based on maximizing your impact and minimizing your costs. Possible priorities for building surveys include:

• High energy use or cost (kilowatt-hours or dollars)
• Intensity of energy use (watts per square foot or dollars per square foot)
• High connected lighting load (kilowatts)
• Large numbers of inefficient lamps
• Higher-cost utility billing schedules
• Building use or location
• Long hours of use or large size

There is even a rationale for giving priority to the first building managers to respond to the announcement of program availability: these individuals may be more likely to implement the recommendations, which is the ultimate goal of a survey program.

Whatever your basis for selecting and prioritizing buildings, it should be decided before the building questionnaires are distributed. However, it is also wise to allow for some flexibility so that you can survey an extra, lower priority building at a remote location, rather than leaving it for a second trip later in the program. One way to build this cost-saving approach into the priority calculation is to select and prioritize groups of buildings at the same location, rather than individual buildings. That way, any particular site is only visited once.

Building Assignment

The purposes for assigning buildings to particular interns are to hold down program costs by minimizing travel, to provide overall guidance to each intern and to give each intern a sense of responsibility for a specific group of buildings. In the interest of minimizing travel costs, it is best to group buildings geographically and then assign a particular intern or team of interns to each region. Interns may also be assigned buildings in several regions to maximize their exposure to different designs and environments.

During employment interviews, interns should be asked how much they would like to travel and if there are particular regions where they would or would not prefer to travel. Those desires should be a strong guide to regional assignments, tempered by the supervisor's evaluation of the intern's maturity and ability.

In some survey programs, minimal travel may be required. In those cases, criteria for building assignment may be based more on the type of building and the supervisor's evaluation of each intern's ability. It is usually still best to have only one or two interns assigned to a particular location or political subdivision, so that building managers don't have too many different interns working in their buildings.

Supervisors need to be aware of each intern's progress and be ready to make reassignments, if necessary, for the good of both the intern and the program. A balance needs to achieved between individual responsibility and a team mentality in which interns believe that their work contributes to the success of the overall program.

Intern Selection

The success of the intern survey program will depend greatly on the talents, capabilities, dependability and dedication of the interns. Since internships are generally of short duration, there is not much opportunity to make major personnel changes once the program is underway. Correction and even disciplinary procedures may be needed occasionally, but losing or replacing an intern will handicap your efforts because of the retraining requirements or reduced program output. The best defense is careful selection in the first place. You can increase

your program's chances for success by selecting interns who already have an interest in your program's basic objectives, have demonstrated technical competence and come with good personal references. Some items to consider when recruiting interns:

- Place employment announcements and job descriptions at universities, colleges, trade schools and high school classes that offer courses relevant to your program objectives. You may want to restrict advertisement to students in specific fields such as building sciences and other technical disciplines or you may want to require completion of certain classes or a particular number of credits. The purpose of the targeted advertisement is to allow the educational institution to act as a screening mechanism for potential interns as well as to locate students who will be most likely to profit educationally from the internship.
- If the target buildings are geographically dispersed, consider recruiting interns from different regions and having them work out of remote offices in the areas where their buildings are located. This allows interns to work in areas with which they are familiar and can reduce program travel expenses.
- Successful interns must be highly self-motivated. They will need to take initiative to make contacts, plan inspection trips, perform analyses and complete reports with little administrative coaching. Selecting self-motivated interns allows the supervisor to focus on administrative activities.
- Interns' dependability and honesty is vital to your program. Interns must be at their planned workplace, doing their job and keeping accurate records of their time and expenses, because a supervisor won't have time to oversee everybody's work habits. Treat the information from references very seriously.
- A valid driver's license will be required if your program requires significant travel. A dependable, insured private vehicle may also be a requirement unless your program can provide vehicles for interns.

These objectives should be restated and emphasized when students are interviewed for the internships. Develop standard questions to be asked in all interviews. Standardized questions should also be used when requesting references on applicants. Even though the internship is a temporary position, you should be thoroughly professional in your hiring practices.

A sample job description, pre-interview information sheet, interview questions and reference request are included at the end of this chapter starting on page 30.

Program Tools

This section will discuss decisions regarding survey types, analysis hardware and software, equipment and supplies and office space. These are all tools that interns will need to produce lighting surveys effectively.

Survey Types

The program goals, funding sources and report requirements will usually dictate the sort of survey to be performed. The main question is whether the survey will be a comprehensive inventory of lighting equipment with recommendations of all energy-saving upgrades. This is the approach required under the EPA's GreenLights Memorandum of Understanding. If a comprehensive survey is not required, then program goals must be carefully considered. Will entire buildings be surveyed or just areas with certain uses? Are only particular technologies to be considered or will interns have considerable freedom in designing lighting system improvements? Will the report present various options for certain spaces or just the one considered optimal by the intern? Will upgrades be presented individually or will a package of upgrades be recommended, with savings estimates to include interaction between control and luminaire recommendations?

Analysis Software

The selection of analysis procedures depends on the survey type selected. If a comprehensive survey is to be employed, particularly for buildings owned by GreenLights partners, then the EPA's Decision Support Software is the most likely choice. It does not operate perfectly in every situation, but it does provide a systematic format for analysis of almost all lighting equipment in a building.

If a comprehensive survey is not required, then there are several analysis methods available. These essentially automate simple hand calculations in which the current lighting cost, based on watts and hours of use, is compared to the estimated cost of the recommended upgrade. The calculated savings are then compared to the cost of the upgrade. If your program only provides surveys for small, simple buildings, actual hand calculations may be sufficient for your analysis needs. These require only a four-function calculator and possibly a standard calculation form. There are several drawbacks to using hand calculations: they are more prone to math errors than computer calculations (requiring extra technical review), handwriting is more difficult to read than printed output and calculations quickly become tedious for the interns. This makes it less likely that the necessary "what-if" calculations will be done to optimize recommendations.

If justified by the number of separate calculations, there are several ways to automate lighting calculations. Any spreadsheet can be used to prepare a simple template for lighting calculations. This will provide consistent, readable output and as long as the cells with formulas are protected, math errors will be prevented. This reduces the reviewer's job to verifying that entry data is correct. Addition of spreadsheet macros can provide utilities such as simple error checking, product and price catalogs and automatic printing. If you add too many features though, you might as well purchase single-project calculation software. These may be based on spreadsheet or database programs, but usually include the error checking and product and price catalogs. Some may even recommend upgrades or provide databases of common substitutions. These features greatly speed up comparison of several alternate recommendations. As software gets more sophisticated, however, some flexibility will be lost and occasionally you may still find that the desired recommendation requires calculation by hand or a simple spreadsheet.

Hardware Requirements

The analysis methods selected will determine hardware requirements. If you are using hand calculations exclusively, all you really need is a simple calculator or adding machine. User-written spreadsheets vary in their hardware requirements, depending on the base spreadsheet selected. Lighting project calculation software for PC-compatible computers typically requires lots of conventional memory, so it's a good idea to get a computer with additional memory above one megabyte and configure the computer to load as much into upper memory as possible. Speed is not a great consideration for this software because the calculations are usually fairly limited.

Whole-building analysis software, on the other hand, can require tremendous computer resources. For a program such as Decision Support System you should probably have at least a 386 computer operating at 25 MHz and a 486/33 is desirable. The software will run reliably on lesser computers, but most analyses take too long. The problem is not so much in the computer, which can be left to run overnight, if necessary, as in the interns' interaction with the computer. Typically, there will be system crashes while interns are getting used to the survey and software and it is very frustrating to have the crash occur after the computer has been tied up all day running an analysis. Faster computers mean that any problems are identified and can be fixed more quickly.

Most lighting software can be run over a local area network, but lacks support for simultaneous access to network data. This is not a major problem if you have sufficient hard disk space to store multiple copies of programs and data. Even if a network is available, it may be better to store stand-alone programs on individual

computers, as long as each intern works at only one computer. The network can then be used to route output to a common printer.

Printing requirements for spreadsheet and single-project analyses are not a problem. The printed output for each project is only a single page or several pages. These can be printed locally with either a dot-matrix or laser printer or routed over a network. But, whole-building analysis software can severely tax your printer's capabilities — a complete report for a moderate-sized building can exceed 100 pages. You should have a printer capable of printing at least four pages per minute to avoid long delays. You should also train interns to review output on the computer screen before printing, to make sure that only the correct output is printed. Finally, remember to budget for printer paper and replacement toner cartridges or ribbons.

Consider renting computers and printers for the intern program, unless the necessary equipment fits within a larger computer acquisition and upgrade plan. Renting provides the quality of equipment you need for the time you need it, and the costs are easy to track.

Equipment and Supplies

In addition to a calculator or computer and printer, interns will need measurement equipment and some basic office equipment and supplies. Depending on your interns' schedules and locations, some or all of these items may be shared.

The most basic lighting survey equipment consists of a clipboard and pencil, a lightmeter and a tape measure. There are small, analog lightmeters costing only about $60, which work quite well for a while. After repeated trips to the floor, they tend to lose calibration and recalibrating them is difficult. Digital lightmeters maintain calibration fairly well, even with the abuse that accompanies regular use. The single-unit model seems to be a little easier to use than one with the display separate from the sensor, because it only takes one hand to operate. Special features such as peak-hold and averaging capabilities may be used occasionally, but are generally wasted in these surveys. A ten- or 12-foot tape measure is useful for measuring ceiling height, room dimensions and plenum depths. An electronic distance meter is a nice time-saving addition if you have the budget for it.

Another very useful tool is a small flashlight, preferably one with a halogen lamp which can be focused. This is useful for reading information printed on lamps when the lamp is turned off. It is also useful for locating switches in dark rooms and inspecting plenums.

Architects' and engineers' scales should be provided for reading room dimensions from plans accurately. This will reduce on-site time for the survey.

Interns should be provided with reference material on lamps, luminaires, ballasts and prices for all of these. Manufacturers' catalogs are usually provided

free of charge. Catalogs that list mean or average lamp lumens are more useful than those listing only initial lumens. Other sources of reference materials are listed on pages 58-63. You should also provide instructions for any software and example calculations for typical lighting upgrades.

Finally, typical office equipment such as staples, tape, correction fluid, paper, pens and pencils should be provided for the interns. If you are using hand calculations or adding notes to software output, you may want to provide a typewriter — it makes reports easier to review. If fixtures in several rooms are being analyzed as a single project, a ten-key adding machine simplifies the fixture counting.

Office Requirements

Interns need some sort of established office space. Working out of homes is one option. This reduces program costs for office space, but may be too unstructured and require more self-direction than most interns are ready to handle. It may also require extra equipment which could be shared if interns were housed in one or more offices.

You will probably choose to arrange office space in a more traditional setting. The office should include desks or tables and chairs and space for files and small item storage. A copy machine should be available — one with reduction capabilities is very useful for making field copies of floor plans. Telephone service must be available if interns are to make their own arrangements for walk-through surveys. A fax is also a benefit, although it would have been considered a luxury a couple of years ago. Finally, there should be access to a receptionist or an answering system, so that messages can be recorded while interns are out of the office.

Close proximity to the program administrator and technical adviser are desirable to facilitate answers to questions and rapid feedback on technical reviews. Nevertheless, it is possible to house some or all of the interns at locations different from the program administrator. It is more desirable to have adequate facilities for interns than to have them housed nearby. Remote office space will also reduce travel costs for most surveys, but may increase travel costs to centralized meetings. Finally, having several interns assigned to different offices will reduce the impact on individual office environments. Usually, program partners, utilities or local governments will donate space and services for a time, so there should not be any office rental costs.

Two or three interns can share an office space with a desk and table fairly effectively. Usually, not all interns will be in the office at the same time, so this will provide room for one to work at a computer and another to use the table for plan review or trip planning. A 100- to 150-square foot space is adequate for two or

three interns, providing other support services are available elsewhere in the office. Five interns can also share three workspaces in a 200-square foot office area.

Procedures

This section discusses those administrative, financial, program status and technical review issues which must be decided prior to intern training.

Administrative Procedures

By the time interns actually begin work, you should have in place procedures for all common administrative, financial and personnel situations. Timesheets, scheduling and trip planning forms, reimbursement requests, telephone logs, mileage logs and any other paperwork should be available and their proper use clearly and simply communicated so that interns can concentrate on learning to survey rather than digging through a paper chase.

There should also be a well-defined process for handling survey reports. This process should start with completion of the draft report and include each step through which the report passes until it is delivered to the building manager and copies are placed in the appropriate program files. In between, there may be several reviews, some recalculation and rewriting, copying and mailing. There should be a report tracking system in place to show that each report has gone through all the proper steps before it is delivered. Ideally, this system would also be able to track the location of the working file for each building and its current status in the survey process.

Survey Reports

No matter which modeling or lighting calculation software is selected, the reports are generated for lighting surveyors and generally unfit for normal human consumption and comprehension. You should carefully consider the audience for your program's lighting survey and design the report's content and style around their needs. It may be advantageous to design several reports, customized for various entities connected with the survey such as the building manager, the building owner, the survey program sponsor, the local utility and the state energy office. Here are some items which should normally be included:

- Cover letter which includes who to contact, other available information and a disclaimer
- Room-by-room or project-by-project listing of recommended upgrades
- Summary sheet of costs and savings (table or graph)

- Building plan identifying locations of recommended upgrades
- Building-specific notes or comments by the intern
- Standard pages describing the typical technologies recommended

"Other information" might include raw data, review data, notes on technologies or specific upgrades not recommended, fixture and equipment counts and various summary reports. These types of information are easily produced from the modeling software, but will probably not be desired by the initial recipient of the report. Readers can request this information later, when they are ready to implement recommendations or need to schedule further study or design work.

Technical Review

To protect the credibility of your office and the survey program, all surveys should be reviewed for technical accuracy and appropriate recommendations. The more complete the review process, the less likely a survey will be released that contains inaccurate or inappropriate information. Determining the type of reviews to be completed and the process to be followed for reviews will prevent confusion when completed surveys are ready for review. Some issues you may want to consider during the development of your technical review procedures:

- Who will be providing the technical review? What is their technical experience? Where are they located?
- Will interns be reviewing each others' reports? If so, you may need to locate intern offices to accommodate these reviews. Extra training will also be necessary.
- What time constraints do the technical reviewers have? A thorough review of a large report may require more than an hour. Are reviewers being paid or reimbursed for their time?
- How and where will the approved surveys be assembled for printing? Will your program need to cover the postage costs required to send them to or from this location?

Given the right supervisors and partners, technical review does not appear to create a large problem. However, this does not reduce the importance of a thorough technical review process. A successful review process can teach your interns what

types of recommendations are appropriate and successful, provide consistency among reports and ensure the credibility of your program.

Recordkeeping Procedures

Unless your target group of buildings is so small that accurate records can be kept by hand, you will want some sort of computerized database to organize building contacts and pre-survey data, prioritize surveys, mark assignment of buildings to interns, record progress during the survey process and record survey results for later compilation. A flat-file database will work fine, but if your target buildings are generally grouped in complexes and you have a database programmer available, a relational database structure is more appropriate. Examples of typical database fields are shown on page 18.

You should also plan for long-term archiving of raw survey data, calculations, recommendations and reports. How much of this will be maintained electronically, how much in paper files and what should be discarded after certain dates are typical issues to be considered.

Pages 30-37 illustrate examples of documents and forms developed by the Nebraska Energy Office to recruit interns and request pre-survey building data.

Job Description for Summer Lighting Interns
Nebraska Energy Office, 12-17-91

The Nebraska Energy Office is seeking six Architecture or Engineering students for full-time internships during the summer of 1992. These interns will survey the lighting systems in school buildings throughout the state and prepare reports recommending lighting improvements. Interns will gain experience in practical energy conservation and technical consulting methods.

Educational qualifications are admission to the College of Architecture or completion of two years of a curriculum in the College of Engineering and Technology.

Candidates must be highly motivated and able to work with minimal supervision. They will be located throughout Nebraska, so intended summer residence will be a factor in selection. Each intern must have a valid driver's license and access to a private vehicle, as the job will involve considerable travel and occasional overnight stays. Physical agility is required for tasks such as climbing ladders.

Employment will begin with two days of training in Lincoln following Spring semester final exams, and will end with an evaluation meeting in Lincoln the second week of August. Wages will be $5.50 per hour with expenses reimbursed. Architecture students may also receive independent study credit.

- - - - - - -

In addition, the Energy Office is seeking one student for a half-time internship beginning in late March and continuing through the Summer of 1992. This intern will be located in Lincoln and will perform data entry and analysis, review survey reports and provide administrative support to the interns described above. Educational qualifications and wages are the same. Some field survey and report writing work will be available if credit for independent study is desired.

- - - - - - -

The application closing date for these positions is February 7, 1992.

For further information, or to make application, contact:

Prof. William Borner
246 Architecture Hall

Constance (Connie) Husa
W181 Nebraska Hall

Application for Internship

Nebraska Energy Office

Lighting Efficiency Survey Program

last name	first name	initial	social security #	home phone #
mailing address	city	state	zip	daytime phone #

intended summer address	city	phone #	beginning date

Do you intend to take summer courses? ☐ yes ☐ no If "yes", what course and what time does it meet?	current GPA	number of credit hours completed

Architecture students

Have you completed or are you currently enrolled in Arch 459?
☐ yes ☐ no

Verification of application or admission to the College of Architecture

signature of dean or academic adviser — date

typed name and title — phone #

-OR-

Engineering students

major _____
class ☐ sophomore ☐ junior ☐ senior

Verification of completion of 4 semesters (including current semester)

signature of dean, department chair or academic adviser — date

typed name and title — phone #

most recent employer			supervisor	phone #
employer's address	city	state	period of employment from	to
description of duties				

second most recent employer			supervisor	phone #
employer's address	city	state	period of employment from	to
description of duties				

additional reference (not a relative) name	phone #	relationship to you	
mailing address	city	state	zip

I authorize the Nebraska Energy Office to contact the individuals named above for the purpose of obtaining and/or verifying information related to this job application.

signed _____ date _____

Return completed application to Prof. William Borner (Arch 246) or the Nebraska Energy Office by 4:00 pm, Friday, February 18, 1994.
questions: contact Lynn Chamberlin, Nebraska Energy Office, PO Box 95085 (1200 N Street, Suite 110) Lincoln NE 68509, 471-2867

Pre-Interview Information for Lighting Internships - Summer 1994

Job Description

The Nebraska Energy Office is seeking six Architecture or Engineering students for full-time internships during the summer of 1994. These interns will survey the lighting systems in state-owned buildings throughout Nebraska and prepare reports recommending energy efficiency improvements. Interns will gain experience in practical energy conservation and technical consulting methods.

Interns must be highly motivated and able to work with minimal supervision. Each intern will be given background information on 40-45 buildings for which he/she will perform lighting surveys. The intern will be responsible to schedule an appointment, survey the lighting system and prepare a complete report on each assigned building.

Energy Office personnel will supervise the interns and provide training and individual help as needed, and will review reports to make sure they are complete and correct.

Wages. The pay rate is $5.50 per hour, from which taxes and social security will be deducted.

Other Benefits. Interns do not receive insurance benefits, paid holidays or vacation or sick leave. They are considered temporary full-time employees.

Reimbursable Expenses. Meal expenses are reimbursable up to $20/day, as long as they are taken as part of overnight travel. There is no reimbursement for meals on 1-day travel. Mileage is reimbursed at 27½¢/mile. You must present receipts and keep detailed records of actual expenses and miles driven.

Lodging Expenses. Overnight lodging will be reserved and paid directly from the Energy Office. You must plan your travel in advance so that appropriate arrangements can be made.

Personal Vehicle. This job will require extensive travel for which you must provide your own vehicle. You are responsible to maintain insurance on this vehicle. You must have a valid drivers license.

Physical Ability. Some physical agility is required for tasks such as climbing a ladder.

Office Hours. Normal office work hours are 8am to 5pm with a 1-hour lunch break. When you are not traveling, you should be in the Energy Office during these hours. The work week is limited to 40 hours with no overtime. If you are traveling outstate, you may need to arrange your schedule to quit earlier in the day on Friday to avoid exceeding 40 hours. This should be authorized in advance.

Schedule. Employment will begin May 11 with three days of training, and will end on August 12.

Holidays. State offices will be closed on May 30 and July 4, but interns are not paid for the holidays. You may arrange your travel schedule to work 40 hours during the balance of these weeks, or you may work short weeks. A limited number of personal holidays (without pay) may be authorized.

Independent Study Credit. Architecture students may receive independent study credit related to the summer work. You must arrange this with a faculty member prior to the summer.

Student Intern Interview Questions/Format

*Name:*_____ *Interviewed By:*_____

The interviews will be started with a review of the program, its purpose and the responsibilities associated with the internship positions.

1. You've had a chance to look at the job description, would you give us a brief description of your past employment and the type of responsibilities that are most relevant to this position.

2. In your previous work experience what type of direct contact did you have with clients? Were you comfortable with that contact? (We should clarify at this point that the interns selected will have direct contact with a large number of individuals and they will need to feel comfortable with this type of direct contact.)

3. Are you planning on receiving class credit through the College of Architecture for the internship program?

4. Are you planning on taking any classes during the summer sessions?

5. Are you physically able to make inspections that may include climbing?

6. Do you have any questions about the internships under the state level?

7. This position will require self-motivated people who need minimal supervision. You will need to schedule your travel and office time (within constraints) and be responsible for making timely progress on your assigned building surveys. Will you be able to work in this type of environment?

8. Are you confident with your math skills through the physics level?

9. Do you have any other questions?

10. How did you hear about the position?

11. Do you have anything that you would like to add that would explain your qualifications on why we should hire you for the position?

Example Reference Check Sheet

At least one reference was contacted for each applicant who scored well in the interview. Past employers were contacted first, followed by personal references if necessary.

Applicant Name: _____

contacted: _____
_____
_____

checked by:_____ date/time:_____

1. Verify dates of employment and job description:

2. What was your overall impression of this employee?

3. Was employee dependable and punctual?

4. Did employee show initiative in completing tasks?

5. Was employee able to work without supervision?

6. Did you have any reason to doubt the employee's integrity?

7. Did the employee have a good work attitude and respond well to supervision?

8. How did the employee interact with co-workers and clients/customers?

9. Would you hire this employee again?

10. Any other information which would help us make this employment decision?

Nebraska School Lighting Efficiency Program

Lighting Questionnaire And Survey Application

☐ I request a free lighting survey and report from the Nebraska Energy Office.

SCHOOL DISTRICT AND BUILDING IDENTIFICATION

School District or Organizational Unit Name ☐ Public ☐ Private | School Building Name

Street or P.O. Box | Building Address or Location

City | County | Zip Code | Name of Contact Person | Phone No. ( )

If you are applying for Lighting Surveys on more than one building, please complete one of these questionnaires for each building.

BUILDING USE INFORMATION

Total Square Feet Heated or Air Conditioned | Average Annual Operating Hours | Year of Original Construction: Year(s) of Addition(s):

Functional Use (check all that apply) ☐ Administrative ☐ Classrooms ☐ Maintenance ☐ Transportation ☐ Cafeteria ☐ Gymnasium /Athletic Complex ☐ Shop ☐ Other (specify) _____

ENERGY SOURCE AND HISTORY INFORMATION

Primary Fuel Supplier Name | Alternate Fuel Supplier Name | Electricity Supplier Name

Complete the Energy Consumption History below using the most recent 12 month period

Primary Fuel Type: _____				Alternate Fuel Type: _____				Electricity			
Mo.	Year	Units	Dollars	Mo.	Year	Units	Dollars	Mo.	Year	Units	Dollars
			$				$				$
TOTALS				TOTALS				TOTALS			

UTILITY WAIVER

_____ authorizes the Nebraska Energy Office to obtain past, present
(District or Organizational Unit)

and/or future energy consumption information from the energy supplier(s) named above.

sign here ◆ _____ Signature and Title of Certified School Representative

_____ Date

Be sure to complete the reverse side of the form.

Lighting Information:
For each area of your building please check the box which indicates the type of lighting in use. If you don't know, put a question mark in the box. If you have different types of lighting in the area, please check all appropriate boxes. If this type of area is not present in this building, indicate "not applicable". If your building has a number of additions and it is too difficult to summarize the different types of lighting in the additions, you may use more than one questionnaire.

Hallways:	☐ Incandescent	☐ Fluorescent	☐ Not Applicable	☐ Other: _____ (Specify)
Stairwells:	☐ Incandescent	☐ Fluorescent	☐ Not Applicable	☐ Other: _____ (Specify)
Classrooms:	☐ Incandescent	☐ Fluorescent	☐ Not Applicable	☐ Other: _____ (Specify)
Exit Signs:	☐ Incandescent	☐ Fluorescent	☐ Not Applicable	☐ Other: _____ (Specify)
Locker Rooms:	☐ Incandescent	☐ Fluorescent	☐ Not Applicable	☐ Other: _____ (Specify)
Gymnasium:	☐ Incandescent ☐ Mercury Vapor	☐ Fluorescent ☐ Metal Halide	☐ Not Applicable	☐ Other: _____ (Specify)
Cafeteria:	☐ Incandescent	☐ Fluorescent	☐ Not Applicable	☐ Other: _____ (Specify)
Entrance/Lobby:	☐ Incandescent	☐ Fluorescent	☐ Not Applicable	☐ Other: _____ (Specify)
Parking Lot & Outside Lighting:	☐ Incandescent ☐ Mercury Vapor	☐ High Pressure Sodium ☐ Metal Halide	☐ Not Applicable	☐ Other: _____ (Specify)
Outside Lighting Control:	☐ Switch or Breaker	☐ Timer	☐ Photocell	

Comments: _____

_____

_____

Nebraska Energy Office
State Capitol
Ninth Floor
P.O. Box 95085
Lincoln, NE 68509-5085
(402) 471-2867

State of Nebraska - Green Lights Program Building Data 04/22/93

Building Identification:

Building Identification:

_____

_____

_____, NE _____

County: _____

Legislative District: __

Contact: _____

Phone: (____) ____-_____

Building Owned or Operated by:

Agency Number: _____

Agency: _____

Division: _____

Contact: _____

Phone: (____) ____-_____

Complex Name: _____

Building Use - Primary: _____

Secondary: _____

Operating Hours - Full Use: _____ hr/yr ("open for business")

Part Use: _____ hr/yr (additional for cleaning, etc)

Constructed In: _____ Construction Type: _____

Remaining Life: ___ yrs Square Footage: _____ (net) # Floors: __

_____ (gross)

Primary Heating System: _____

Primary Cooling System: _____

Electric Utility: _____

city: _____ phone: (____) ____-_____

Is electricity metered ☐ at the individual building (meter# _____)

or ☐ through a central meter? (if "central", what is the total area of the buildings metered through this central meter: _____ sq.ft.)

Please complete this table using actual billings for this meter:

month	electricity		demand, if metered		total cost
	kWh	cost	kW	cost	
Jan					
Feb					
Mar					
Apr					
May					
Jun					
Jul					
Aug					
Sep					
Oct					
Nov					
Dec					
TOTAL					

Form Completed by: _____ Phone: _____

(please print)

Intern Training

While not providing actual training material for interns, this section should provide the supervisor and/or trainer with a clear understanding of the topics which should be covered and a training format which the Nebraska Energy Office has found effective.

Technical training for lighting surveys involves teaching interns that an ordinary phenomenon, artificial lighting which they have instinctively and unthinkingly used every day of their lives, does not just happen. There is a science, as well as an art, to providing an attractive and effective visual environment and there are good and bad designs for accomplishing this goal. The surveyor's job is to evaluate the current lighting system and visual environment and offer suggestions to improve the lighting while reducing electricity use and cost and resulting air pollution.

An effective training agenda for interns will combine a variety of learning experiences in different settings. Even though interns are used to taking notes in classroom lectures, that is not the most effective way to communicate either the concepts or skills necessary to become a proficient lighting surveyor. This training is the new interns' first exposure to the heart of the job. If selection has been done with care, interns will be capable of understanding the concepts in the technical training, but it is important to present the information in the proper sequence and paced so that interns with less technical backgrounds do not become discouraged.

A sample agenda for technical training is shown on page 39. Other topics such as personnel policies, administrative procedures and other non-technical items should be included at strategic points throughout the agenda. Five consecutive days of training can be fairly grueling, so the first day is typically on a Wednesday, providing three days of training, a weekend and then two final days of training the following week. The sample agenda emphasizes field experience in addition to classroom training. In the classroom, it is easy to lecture without providing clear motivation or a basis for evaluating information. Interns are used to receiving theoretical information in the classroom and then discovering that most of it is not really very useful in the field. The approach described here attempts to demonstrate in the field the sort of information which is vital to the interns' success. Once interns recognize the information they lack and why it is important, classroom training will be enhanced. Frequent changes of location and activity serve to keep everyone refreshed and alert as well as providing opportunities to consolidate what has been discussed so far and ask questions in smaller groups.

Electricity Fundamentals

Some basic electricity terminology is necessary in order to understand the electricity and lighting concepts involved in the rest of training, but there is no need for the student to become proficient in circuit analysis or other electric power

Sample Lighting Intern Training Agenda

Day One

- Program overview, goals and what to expect from the job
- Electricity and lighting fundamentals
- Walking tour of lighting equipment
- Lighting examples and calculations
- Lighting equipment overview and demonstration
- More lighting examples and calculations
- Introduction to economic analysis
- Demonstrate single-project calculation software

Day Two

- Introduction to whole-building analysis software
- Divide into trainer-led teams to survey sample rooms
- Enter survey data, run analyses, review results and compare
- Modify data and analysis parameters and rerun
- Use single-project analysis software to refine analyses

Day Three

- Divide into trainer-led teams (three-five persons) to survey small buildings
- Enter data, run analyses, review results and refine as necessary

Day Four

- Divide into trainer-led teams to survey medium-sized buildings
- Enter data, run analyses, review results and refine as necessary

Day Five

- Divide into teams of two or three without trainers to survey small buildings
- Enter data with trainers on hand to help with computer problems and questions

NOTE: Presentations on administrative and personnel policies, financial procedures and other non-technical items — maybe even some fun, team-building activities — should be interspersed throughout this agenda to break up the sessions.

calculations. One of the most important concepts is a clear distinction between electric energy, measured in "kilowatt-hours," and electric power, measured in "kilowatts" or "watts." This is not an easy distinction — many professionals consistently confuse the terms.

Interns also need to become comfortable with the "kilo-" prefix so that they can instinctively convert between watts and kilowatts by moving the decimal point three places left or right, effectively multiplying or dividing by 1000.

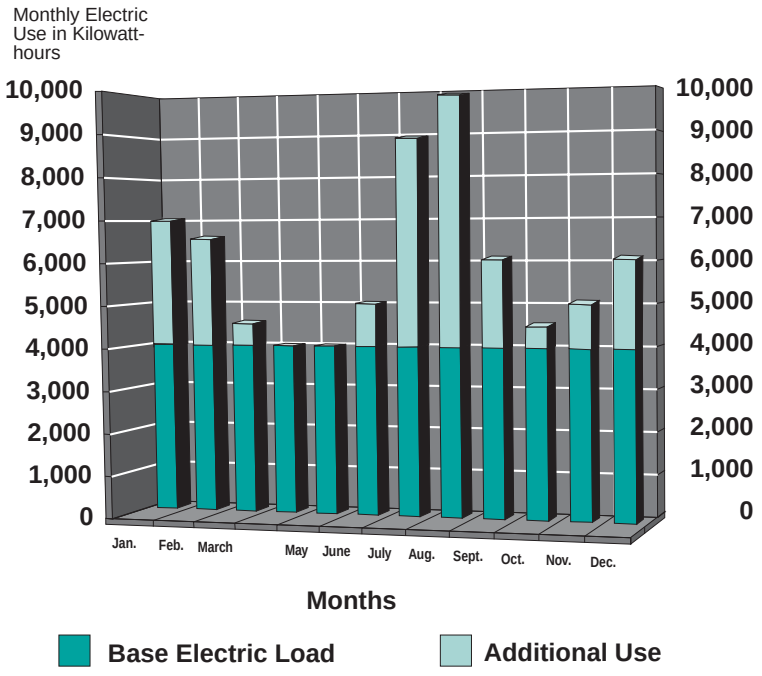
"Volts" and "amps" do not need to be discussed at this time, but interns should be introduced to the idea of alternating current and the concepts of power factor and harmonics. Interns will encounter these terms when they read that a ballast features a "high power factor" or they are asked about "reduced harmonic" lamps, but there's little need for them to be able to discuss the subjects in detail. It's enough for them to recognize the terms, identify them as power quality issues and know to refer such questions to an authority.

Energy Versus Power

It is important to differentiate between kilowatt-hours, which measure the amount of energy delivered or used and kilowatts or watts which measure the rate at which the energy is supplied or used. These concepts can be communicated fairly clearly in the context of an electric bill. From the utility's perspective, power (or demand) represents the cost of providing electric service through equipment such as generators, distribution wires and transformers. The utility charges for demand to recover its fixed costs of owning and keeping this equipment available, no matter how much electric energy is actually used. Demand is measured by a meter which records only the maximum kilowatts — the highest rate of electricity use — each month. On the other hand, energy fees relate to the utility's variable cost of generating electricity, which is usually the cost of coal or other fuel. The more electricity is used, the more fuel has to go into the boiler. The energy charge is measured by a meter which adds up all the energy which flows through it during a month. Of course, there's a lot more to utility bills than these generalities, but it

illustrates the point. This distinction should be discussed to the point that interns are able to understand which lighting efficiency strategies are likely to affect energy use only, and which also impact demand.

Example Utility Bill Analysis



Source: Nebraska Energy Office

Reading Utility Bills

This largely-underrated skill helps keep the lighting surveyor in contact with the real world by focusing on the bottom line of actual energy use, demand and cost in the building to be surveyed. It is recommended to get copies of actual electric bills for twelve months for each building to be surveyed. When these are not available, most utilities can provide a 12-month transcript of charges. As a last resort, the building manager or bookkeeper can usually pick out the monthly electric cost from ledgers and you can work backward from the applicable electric rate schedule to calculate approximate electric bills.

A simple spreadsheet analysis of the billing data provides valuable clues about how much electricity is actually used for lighting. If the billed kilowatt-hours are displayed on a bar or line graph by months, the minimum month (or average of minimum months) usually marks the "base load" which is electricity used for lighting, fans and appliances. Variations in electric use above the base load are often caused by weather and may be unrelated to lighting as illustrated in the chart on this page. Multiplying the monthly base load by 12 months provides a convenient cap for energy savings. In a building with minimal fan and appliance use, where almost all base load electricity is used for lighting, it is unlikely that the most ambitious lighting efficiency program will save more than about 50 percent of this base load on an annual basis. As fan energy and appliance electricity requirements increase in relation to lighting electric use, the fraction of the base load which can reasonably be saved by lighting efficiency improvements decreases.[2]

[2]This is a rule of thumb only. In cooling-dominated buildings with large internal electrical loads and minimal heat loss through the skin, savings from lighting efficiency improvements may be higher than suggested by this method because the improvements also reduce the building's cooling load. This provides additional savings because less electricity is used by the lighting system and then less electricity is used by the air conditioner to remove the heat generated by the lights.

Energy costs can also be quickly calculated from this data. If demand is not metered separately and there is not a great difference between seasonal rates, simply dividing the annual electric cost by the annual kilowatt-hours use will give an acceptable price for most calculations. If you use modeling software which can handle more complex seasonal rates and demand charges, these can be calculated from the same data. The most conservative calculations will arise from reviewing the applicable utility rate schedule and using the energy cost from the highest block rate which applies for each month.

Finally, reviewing billing information prior to the survey can give clues about building use that might otherwise be missed. The intern may need to ask the building manager about the cause of peak usage in certain months. If a load factor is calculated from the demand bills, it may indicate periods of unusually heavy building use. The intern should verify this with the building manager and consider it in calculating the annual hours of lighting use.

Hand Calculations

Even if modeling software will be used for actual energy and cost savings estimates, interns should work out several energy-saving problems on paper with a calculator. This will solidify the numeric relationships in their minds and develop a habit of thinking critically about the relative magnitude of entry data and the savings that result. This thinking skill is vital in reviewing computer output and noticing results that "just don't seem right" for a particular lighting upgrade. Example problems should involve changes in both power and hours of use. Several examples are shown at the end of this chapter starting on page 54. After working through these problems, interns will realize that the computer software is not doing anything they can't understand or duplicate and that the value of the software is that it does repetitious calculations quickly and accurately. This will give interns confidence to spot check results and seek an explanation if answers don't look right.

Pollution Prevention

While discussing electric energy, it's a good time to talk about the environmental benefits of energy efficiency. If fewer kilowatt-hours are used by the lighting system, then fewer need to be generated by the utility. Since most electric generation involves the release of undesirable gases — nitrogen oxides, sulfur oxides and carbon dioxide — to the atmosphere, any decrease in the electricity used by the customer will cause a proportional decrease in these atmospheric emissions. The exact proportion of emissions reduced will vary by location and season, depending on the mix of generation equipment and fuel used by each utility. Although the main focus of the calculations is reducing wasted electricity and saving

dollars, interns should learn that the lighting improvements they recommend will have a direct impact on preventing air pollution as well.

Lighting Fundamentals

The chapters on lighting fundamentals and upgrade technologies from the GreenLights *Lighting Upgrade Manual* have been used successfully in intern training and are recommended as both a trainer resource and a handout. These and other training materials are available from sources listed starting on page 58. Rather than repeating the information in these sources, this chapter will focus on training techniques needed to use these materials effectively.

Walking Tour of Lighting Equipment

Trainers should resist the temptation to plunge directly into a daylong classroom session on lighting equipment. Initially, it is best to provide some very basic lighting concepts, introduce the various lighting sources and then take interns out to explore the streets, observing lamps in their natural habitat. In most settings, it is not difficult to find examples of 20 or 30 different lamps and luminaires within a few blocks of the training facility. Trainers should scout out the most interesting luminaires ahead of time and then lead a 30- to 45-minute tour of the lighting devices. This is an excellent time to introduce characteristics of various sources, such as experiencing the color of rooms with cool white fluorescent lamps compared to those using warmer color lamps or noting that recessed downlights may have incandescent, compact fluorescent or high intensity discharge lamps. If a switch is accessible and the building manager doesn't mind, flicking a high intensity discharge lamp off and then on will provide a graphic example of warm-up/restrike time requirements, to be discussed later in the classroom. Other interesting features might include a noisy ballast, an incandescent lamp placed back into a compact fluorescent retrofit by an unthinking custodian and an occupancy sensor — the one controlling the automatic door is no different from those that control lights. Finally, this is an opportunity to comment on the rampant lighting waste that will undoubtedly be noticed.

Vocabulary

The science of illumination has a large vocabulary all its own which can be overwhelming at first. While there is value in using the correct terminology, the intern forms a unique bridge between the professional illuminating engineer and the non-technical building manager and it is not desirable to encourage the intern to talk like the professional designer. A few, well-defined terms will suffice for most survey work. For example, it is acceptable for the intern to speak of a "fixture"

rather than a "luminaire," as long as it is understood that the term includes all the parts necessary to convert electricity to light and direct that light to the task for which it is intended.

"Watts" do not measure light output. Most interns, along with the rest of the general population, think of light levels in terms of the wattage of an incandescent lamp it takes to provide the desired illumination. "Watts" measure the electric power supplied to the lighting equipment or luminaire. Light output from a lamp is measured in "lumens" and the illumination falling on a surface is measured in "footcandles." Except when looking directly at a light-producing object, what our eyes actually see is the light energy reflected by a surface.

A particular lamp's effectiveness at converting electric energy to light is measured in "lumens per watt." Technically, this value is called "efficacy" rather than "efficiency" because it is not expressed in consistent units. Conceptually, it *is* the efficiency of conversion and there is little reason to make a hard distinction between the terms. All the electric energy that goes into the lamp is converted to heat or light and the most efficient lamp is the one which provides the most visible light for a given input.

Absorption, Reflection and Transmission

Interns should understand that light obeys the "law of conservation of energy." When light energy strikes a surface, three things can happen to it. It may be reflected back or transmitted through the material as light or it may be absorbed and change to heat energy. This has implications for luminaire design. The most efficient luminaire is the one in which the minimum amount of light energy is absorbed by the luminaire itself, leaving most of the light to exit the luminaire via reflection and/or transmission and perform a useful lighting function. Ultimately, all the electricity consumed by the lamp and ballast becomes heat energy, which helps heat the building during the winter,[3] but requires extra cooling during the summer.

Colors of Light

Light is a form of energy called electromagnetic radiation, which also includes radio/television signals and microwaves. The portion of the spectrum called "visible light" is special because human eyes can detect it. Without these light waves entering the eye and stimulating the retina, there is no seeing. Sunlight and all "white" light sources, are a mixture of all the colors in the spectrum or rainbow and the color we use to describe any particular object is actually the color of light that it

[3] Additional heat may be required in the winter to replace reduced lighting energy after a lighting upgrade. If the building is heated by electric resistance, savings may be reduced or eliminated during the coldest months. Other forms of space heat are generally cheaper than electricity, so savings reduction will not be as great. In most temperate climates, it is safe to ignore heating and cooling interactions by assuming that normal summer savings will offset any winter penalty.